

National Aeronautics and Space Administration



# Project Status Report

## High End Computing Capability Strategic Capabilities Assets Program

10 May 2012

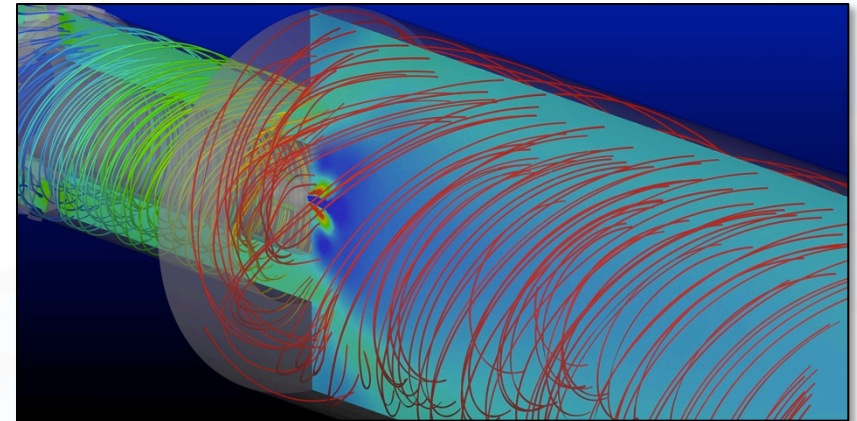
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# New Grid Partitioning Method Improves Parallel Performance of National Combustion Code



- HECC software engineers improved the parallel performance of the National Combustion Code (NCC) by 60% when run on Pleiades; NCC is widely used within NASA to analyze and design combustion related components.
- To obtain this large performance increase, the HECC staff, working with counterparts at NASA Glenn, incorporated a new grid partitioning option, the Recursive Co-ordinate Bisection Method (RCB), into NCC.
- RCB optimizes the grid partitioning based on information about the cells, such as their computational load and proximity to each other.
- Two out of three turbulent spray combustion test cases (representing typical flame tube experiments) showed that the RCB partitioning method improved NCC's performance by up to 60%, compared to the original METIS 4.0.1 method.
- As a next step, HECC experts will investigate the use of the ParMETIS method as another grid partitioning option in NCC, in order to minimize both communication and load imbalances across processes.

**Mission Impact:** Speeding up the computational performance of the National Combustion Code enables NASA users to analyze and solve more complex aerodynamics and combustion problems in gas turbines and engines.



**Figure:** Snapshot from a simulation of an experimental air-blast fuel injector, with stream-tubes showing the swirling airflow, colored by the time the air has been in the combustor. Among its many uses within NASA, the National Combustion Code is being used to simulate the swirler mixing process in turbine combustor design concepts. (Anthony Iannetti, NASA/Glenn)

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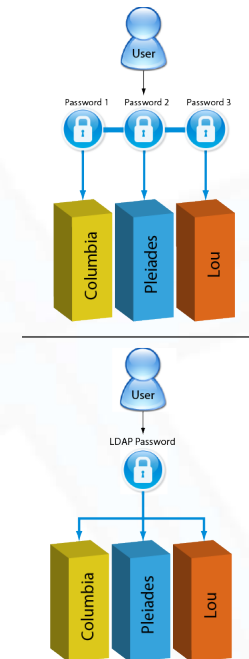


# HECC Deploys New Authentication Servers



- The HECC Supercomputing Systems team recently deployed new LDAP (Lightweight Directory Access Protocol) authentication servers for Pleiades, replacing legacy LDAP servers that had reached the end of their useful lifetime and were no longer supported by the vendor.
- The LDAP servers are configured to enable continuous, high availability for user authentication to HECC resources, with a server on each of the computer room floors.
- The servers currently provide password authentication for Pleiades, Columbia, and Lou. Further integration of LDAP with other HECC resources, such as the ticket tracking system and auxiliary systems, will simplify password management.

**Mission Impact:** The new authentication servers provides a stable, vendor-supported authentication service to HECC users.



**Figure:** The LDAP server provides the HECC users with a single interface to control their password on multiple systems.

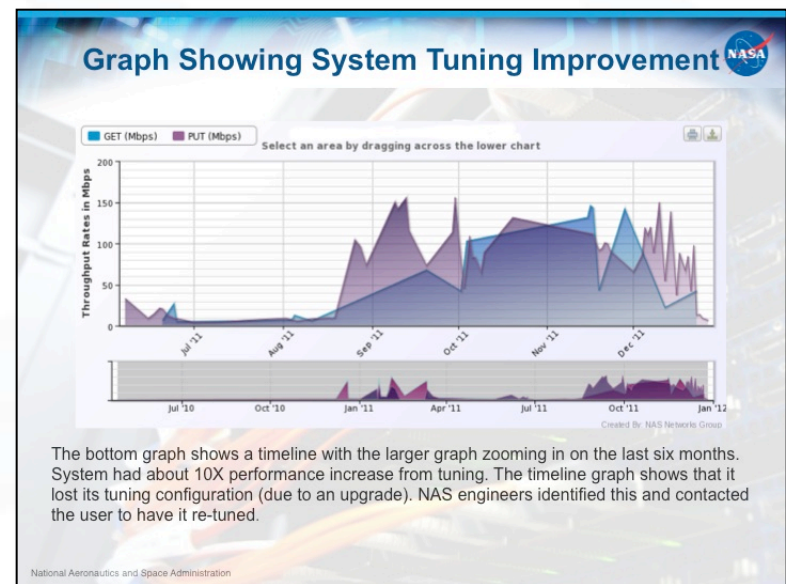
**POC:** Bob Ciotti, [bob.ciotti@nasa.gov](mailto:bob.ciotti@nasa.gov), (650) 604-4408,  
NASA Advanced Supercomputing Division;  
Davin Chan, [davin.s.chan@nasa.gov](mailto:davin.s.chan@nasa.gov), (650) 604-3613, NASA  
Advanced Supercomputing Division, Computer Sciences Corp.

# Webinars Focus on Data Transfer Performance Techniques



- The HECC monthly webinar series recently covered 2 topics that explained how users can get more effective data transfers.
- The March webinar, “Speeding Up Data Transfers,” provided users with techniques for optimizing data transfer performance using a variety of applications, including bbftp, gridftp, bbscp, and scp.
- The April webinar, “Simple Automated File Transfers Using SUP and Shift” featured the Secure Unattended Proxy (SUP) for secure, unattended file transfers; and Shift, a simple, automated, and fast mechanism for getting the highest performance transfer rates.
- Both webinars were well attended by more than 20 users each, the majority of whom participated remotely from areas across the country; some users adopted the techniques soon after the presentations.

**Mission Impact:** Providing faster, easier, and more reliable file transfer mechanisms enables HECC users to better streamline their time-to-solution cycle.



**Figure:** This graph from the HECC webinar, “Speeding Up Data Transfers,” illustrates the network file transfer performance improvements attained using techniques covered in the training session.

**POC:** Nichole Boscia, [nichole.k.boscia@nasa.gov](mailto:nichole.k.boscia@nasa.gov), (650) 604-0891, NASA Advanced Supercomputing Division, Computer Sciences Corp. (CSC); Paul Kolano, [paul.kolano@nasa.gov](mailto:paul.kolano@nasa.gov), (650) 604-4271, NASA Advanced Supercomputing Division, CSC

# HECC Supports the 10<sup>th</sup> Annual SGI User Group Conference



- Strong participation from the HECC Supercomputing Systems team contributed to the success of the 10th Annual SGI User Group (SGIUG) Conference; the three-day event was held April 17–19, in Orlando, Florida.
- The SGIUG event brought together participants from HEC sites across the country and the world, and provided an opportunity for SGI users to interact and share information, as well as to discuss and influence future technologies and products from SGI.
  - At the conference, HECC staff presented four break-out session talks and two general sessions talks, and led a discussion session (see slide 11).
  - HECC's Davin Chan was re-elected SGIUG board president, and Liz Cox was re-elected vice-president and program chair.

**Mission Impact:** HECC supports NASA knowledge-sharing and outreach goals through participation at technical conferences such as user group meetings.



**Figure:** SGI CEO Jorge Titingher follows up with attendees of the SGI User Group Conference, after his Q&A session.

**POC:** Bob Ciotti, [bob.ciotti@nasa.gov](mailto:bob.ciotti@nasa.gov), (650) 604-4408, NASA Advanced Supercomputing Division;  
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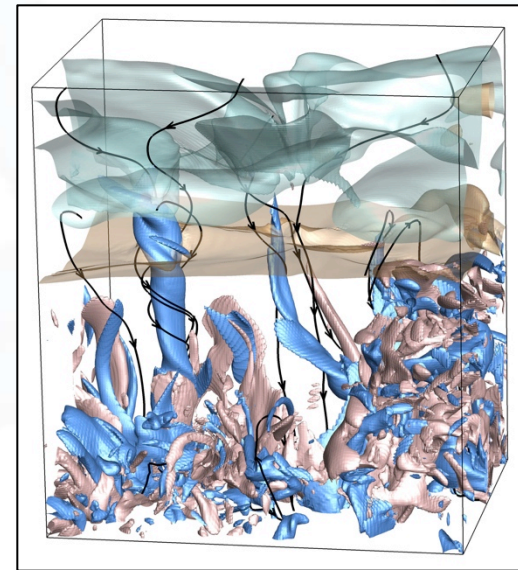


# Simulations Reveal 'Inverted Tornado' in the Solar Turbulent Convection\*



- Using the Pleiades supercomputer, researchers at NASA Ames and Stanford University are producing realistic, radiative hydrodynamic simulations to better understand the complicated, turbulent phenomena on the Sun.
- Results have revealed “inverted tornados,” a newly discovered phenomenon in which vortex tubes form with supersonic swirling flows.
- Combined with observations from the Helioseismic and Magnetic Imager on the Solar Dynamic Observatory, such realistic simulations provide an excellent tool to:
  - Predict space weather to estimate space flight risks, to plan future space missions and experiments;
  - Prevent or reduce the impact of solar blasts on navigation and energy systems;
  - Understand self-organization processes in turbulent magnetoconvection, links between different scales, and Sun-Earth connections;
  - Interpret oscillation and dynamical processes on other stars observed by the Kepler mission.
- Such realistic simulations require large computational resources; Pleiades has demonstrated highly efficient performance for these massively parallel computations.

**Mission Impact:** Numerical models such as these are important for validating and improving solar observation techniques used for supporting the Solar Dynamics Observatory and Kepler missions, and for preparing future mission instrumentation.



**Figure:** Vortex-tube structure extended below and above the solar surface. Volume rendering shows kinetic helicity (positive and negative). Semi-transparent, light-brown surface shows the visible surface of the Sun. The semi-transparent, light-blue surface shows the chromospheric level. *Irina Kitiashvili, Stanford University; Alan Wray, NASA/Ames*

**POC:** Irina Kitiashvili, [irinasun@stanford.edu](mailto:irinasun@stanford.edu), (650) 723-9596, Stanford University; Nagi Mansour, [nagi.n.mansour@nasa.gov](mailto:nagi.n.mansour@nasa.gov), (650)604-6420, NASA Ames Research Center

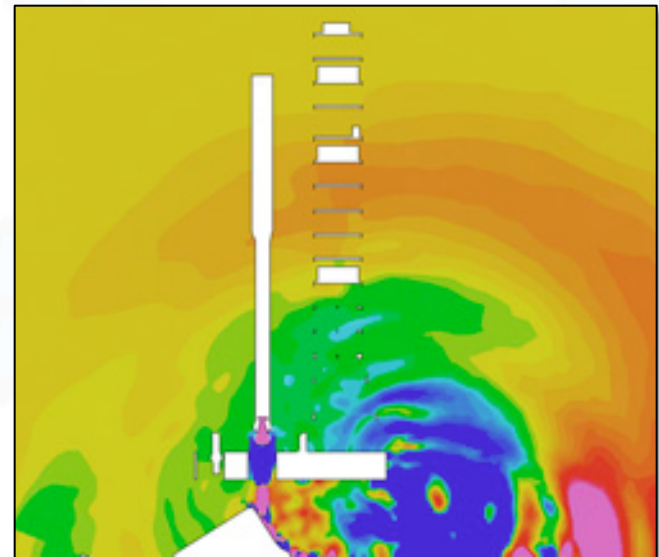
\* HECC provided supercomputing resources and services in support of this work.

# Using CFD to Simulate the Ares I Model Acoustic Test\*



- A robust and reliable computational fluid dynamics (CFD) capability is critical to NASA's rocketry design process—allowing engineers to quickly iterate through design options that would be difficult to assess with traditional methods.
- Researchers at Marshall Space Flight Center (MSFC) are using Pleiades to perform CFD validation tests using data from the Ares I Scale Model Acoustics Test at MSFC—a series of live-fire tests of a scaled rocket motor intended to simulate the acoustic conditions of the full Ares I vehicle at launch.
- These tests have demonstrated the ability of modern CFD tools to accurately simulate the transient startup environment of a rocket at liftoff.
- Simulation results have been compared to a range of pressure measurements from the physical test setup and to visible and infrared imagery of the tests—and showed excellent correlation to real-world results.
- Initial findings helped provide the confidence to move forward with full-scale simulations of liftoff environments for future launch vehicles, such as the Space Launch System.

**Mission Impact:** HECC resources provide critical support to NASA engineers who use computational fluid dynamics to assess the loads and risks for future launch vehicles, such as the Space Launch System, at liftoff.



**Figure:** Snapshot of pressure contours through the centerline of the Ares I Scale Model Acoustics Test simulation as the overpressure propagates through the launch tower. *Gabriel Putnam, NASA/Marshall*

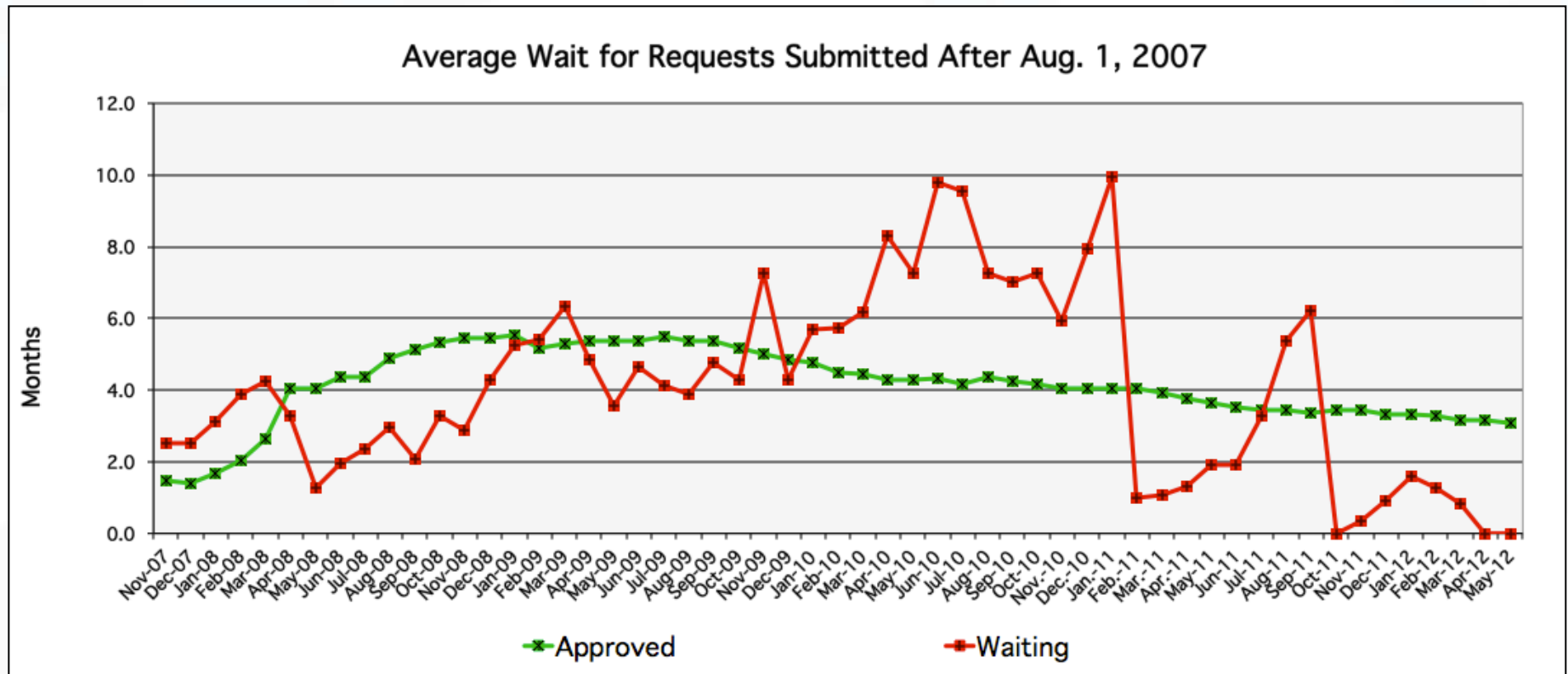
**POC:** Gabriel Putnam, [gabriel.c.putnam@nasa.gov](mailto:gabriel.c.putnam@nasa.gov), (256) 544-9577  
NASA Marshall Space Flight Center

\* HECC provided supercomputing resources and services in support of this work.

# Status of Requests for NAS Computer Accounts by non-U.S. Citizens



- Requests approved: 6; New requests received: 6; Requests waiting: 0.
- The time to approval continues to improve. The six requests that were approved were approved in one month or less.





# HECC Hosts Several Visitors and Tours in April 2012



- HECC hosted 10 tour groups in April; guests learned about the Agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - California Lt. Gov. Gavin Newsom (hosted by Pete Worden) received a technical overview and hyperwall demonstration by visualization expert Chris Henze;
  - D-Wave CTO and Founder Geordie Rose met with Rupak Biswas to discuss a potential quantum computing system;
  - John Abizaid, a retired general in the U.S. Army and former Commander of the U.S. Central Command—currently managing the Hoover Institute at Stanford University—received an HECC overview and hyperwall demonstration;
  - Chris Henze hosted a technical group from the Kepler mission to discuss further collaboration with engineers from both organizations;
  - A large group from the Agency-wide Export Control training received a tour of the computer room.



**Figure:** Attendees from the Agency-wide Export Control annual review meeting listen as Jeff Becker of the NASA Advanced Supercomputing Division, describes the Pleiades supercomputer system.

**POC:** Gina Morello, [gina.f.morello@nasa.gov](mailto:gina.f.morello@nasa.gov), (650) 604-4462,  
NASA Advanced Supercomputing Division

# Presentations and Papers



- **10th Annual SGI User Group (SGIUG) Conference**, April 17–19, Orlando, Florida
  - “Is the Cloud Ready for NASA's Science Computing?” Piyush Mehrotra
  - “Tracking Altix ICE Performance: From Harpertown to Sandy Bridge,” Bob Hood
  - “ICE Logfile Analysis and Visualization,” Jason Rappleye
  - “High Performance Automated File Transfers with Integrated DMF File Management,” Paul Kolano
  - “Lumber: Harvesting Useful Information from Log Files,” David Barker
  - “Usinit: Detecting Uninitialized Variables in Fortran and C/C++,” David Barker
  - Customer Feedback Session, Davin Chan
- **Lustre User Group (LUG) Conference**, April 23–25, Austin, TX
  - “Optimizing Lustre Performance Using Stripe-aware Tools,” Paul Kolano
  - “Lustre Performance Analysis with SystemTap,” Jason Rappleye
- **“Sensitivity of the ice-shelf/ocean system to the sub-ice-shelf cavity shape measured by NASA IceBridge in Pine Island Glacier, West Antarctica,”** Michael P. Schodlok, Dimitris Menemenlis, et al., *Annals of Glaciology* 53(60) 2012, doi: 10.3189/2012AoG60A073\*
- **“Dynamic Coupling Of Convective Flows And Magnetic Field During Flux Emergence,”** Fang Fang *et al.*, *The Astrophysical Journal*, Volume 745, Number 1, 2012, doi:10.1088/0004-637X/745/1/37\*

\* *HECC provided supercomputing resources and services in support of this work.*

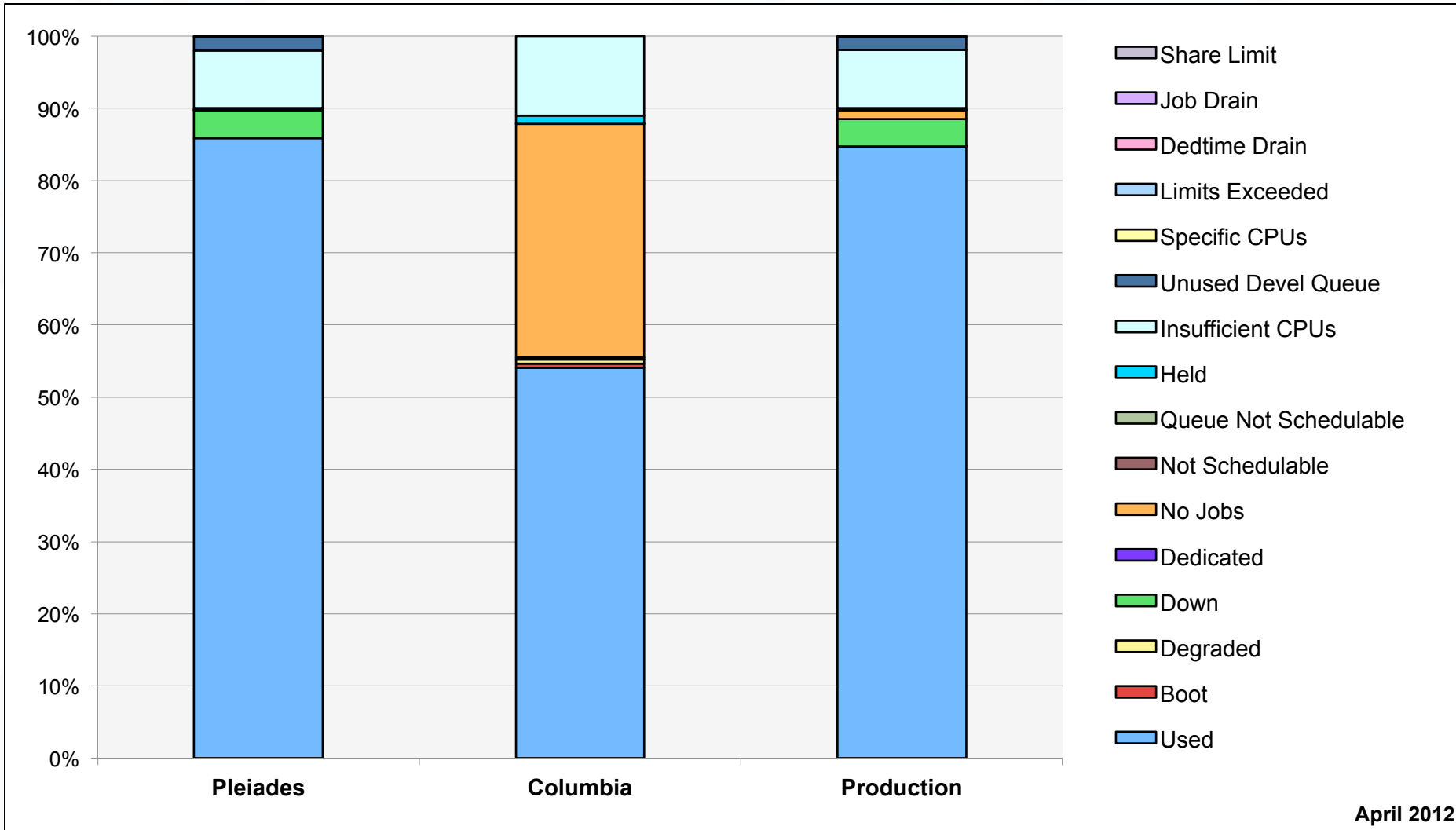


- **A Place for Offshore Wind:** Researchers use weather model to recommend East Coast offshore wind farms, *Udaily (University of Delaware)*, April 24, 2012 – Highlights a study by researchers at the University of Delaware and Stanford University using a weather model to recommend optimal placement of four interconnected wind farms.\*  
<http://www.udel.edu/udaily/2012/apr/offshore-wind-farms-042412.html>
- **Samplify Solutions Transform Processing Paradigms at DESIGN West,** *Electronic Design, Strategy, News*, April 12, 2012 – Features a discussion/description of Pleiades in the context of product solutions for big-data machines.  
[http://www.edn.com/article/521475-Samplify\\_solutions\\_transform\\_processing\\_paradigms\\_at\\_DESIGN\\_West\\_2012.php](http://www.edn.com/article/521475-Samplify_solutions_transform_processing_paradigms_at_DESIGN_West_2012.php)
- **NASA Does Networking Flow,** *International Science Grid This Week*, April 11, 2012 – Spotlights the recent release of the “Flow Analysis Toolkit” Whitepaper, by Nichole Boscia.  
<http://www.isgtw.org/spotlight/nasa-does-networking-flow>
- **SGI Named 2012 Computerworld Honors Laureate:** Next-Generation NASA Pleiades Upgrade Recognized by Exclusive Judging Panel, *SGI press release*, April 2, 2012 – Recognition based on partnership with NASA and the Pleiades supercomputer, honoring “visionary applications of information technology promoting positive social, economic, and educational change.” [http://www.sgi.com/company\\_info/newsroom/press\\_releases/2012/april/laureate.html](http://www.sgi.com/company_info/newsroom/press_releases/2012/april/laureate.html)

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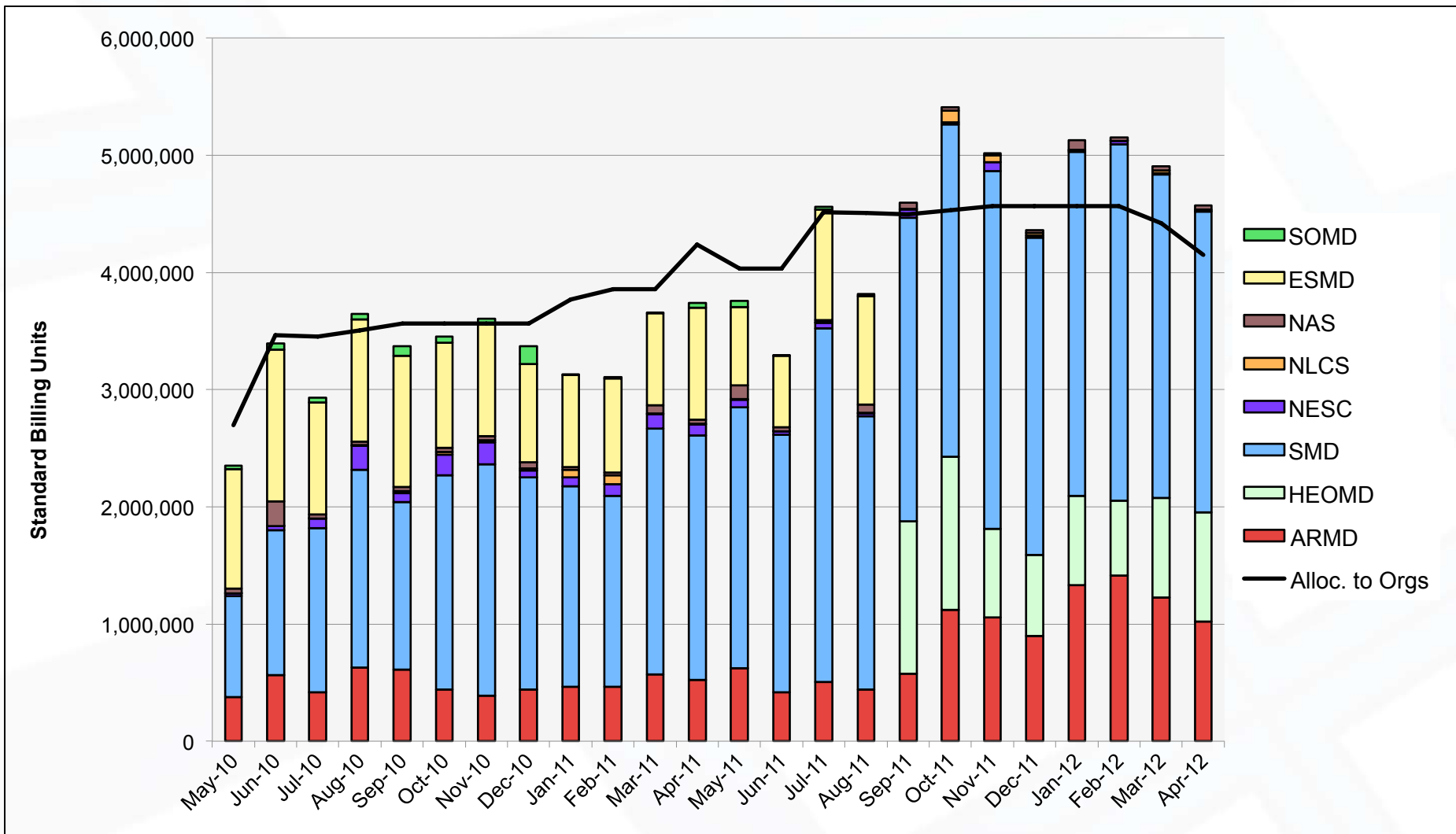


# HECC Utilization

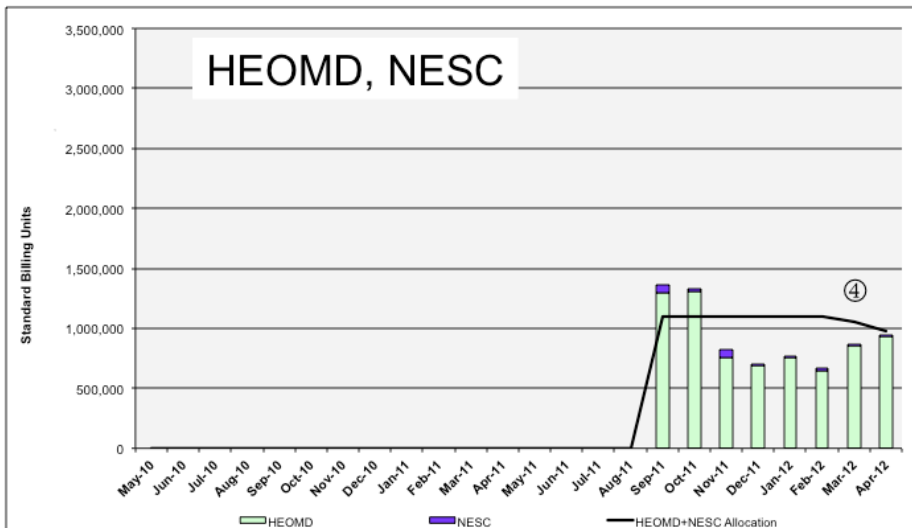
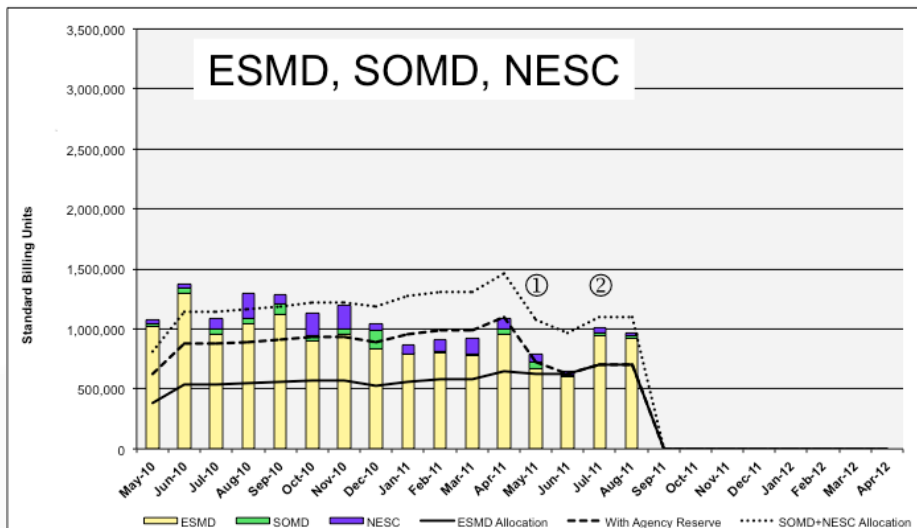
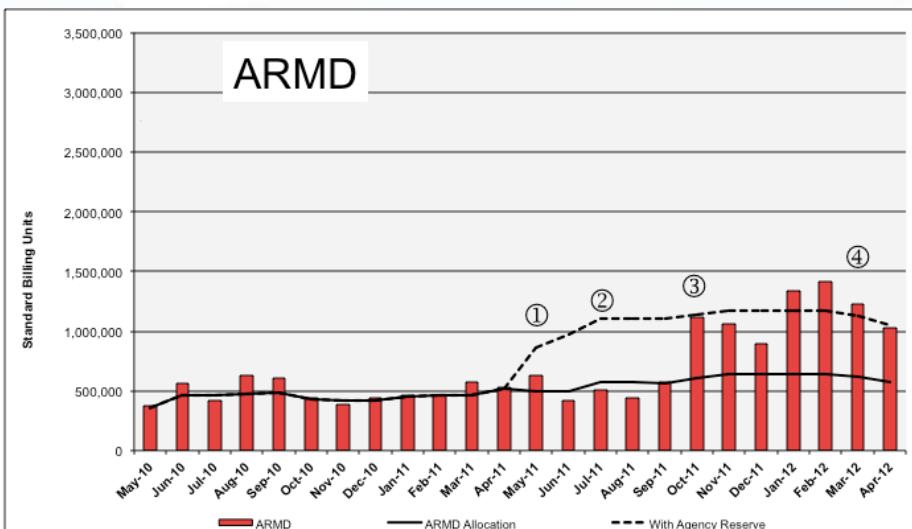
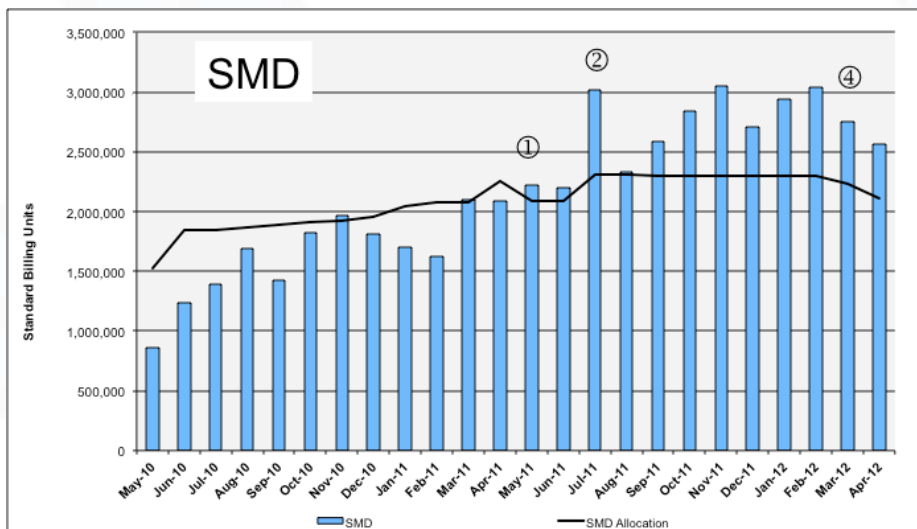


April 2012

# HECC Utilization Normalized to 30-Day Month



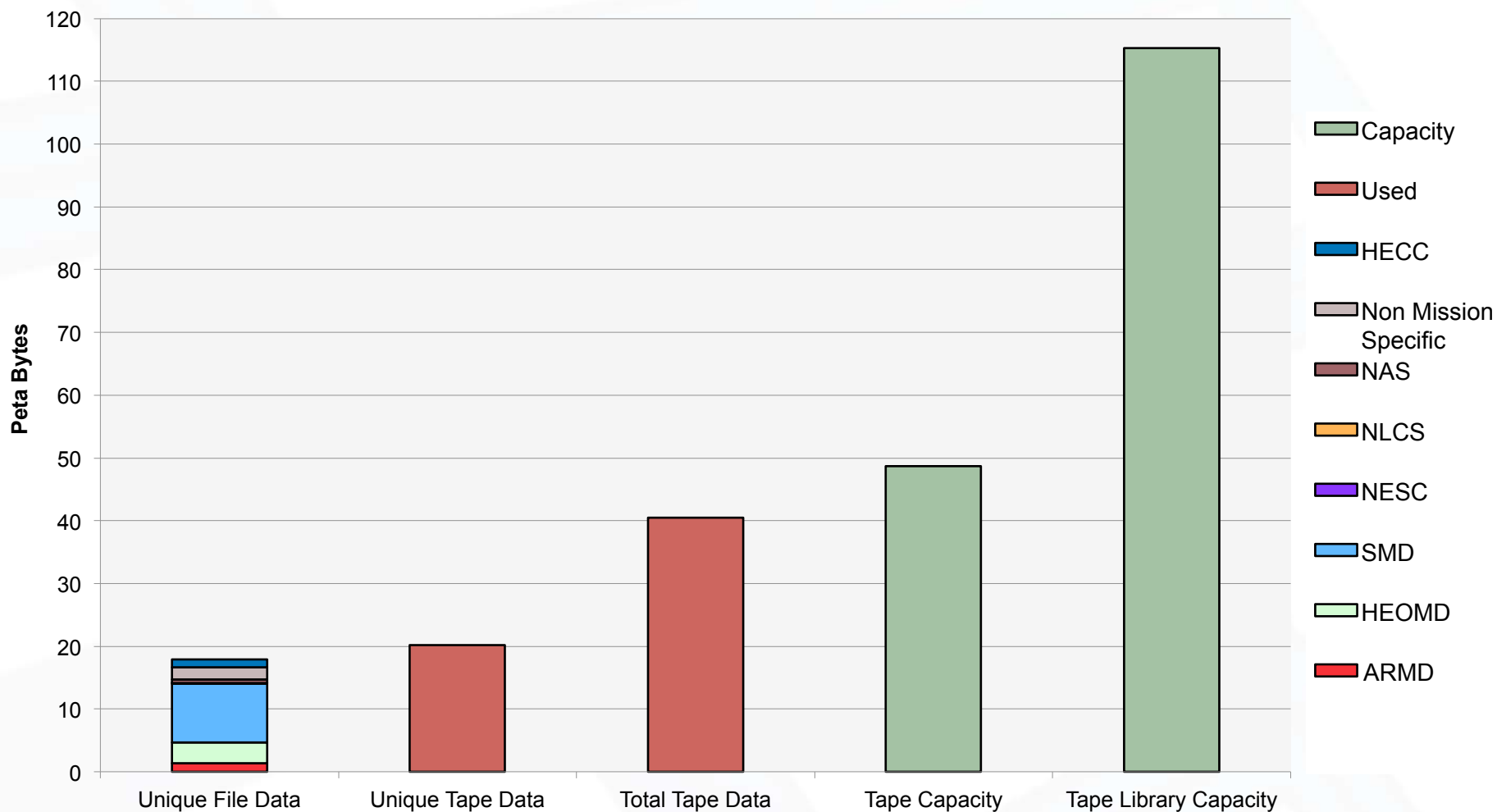
# HECC Utilization Normalized to 30-Day Month



- ① Allocation to orgs. decreased to 75%, Agency reserve shifted to ARMD ② 14 Westmere racks added  
 ③ 2 ARMD Westmere racks added ④ 28 Harpertown racks removed

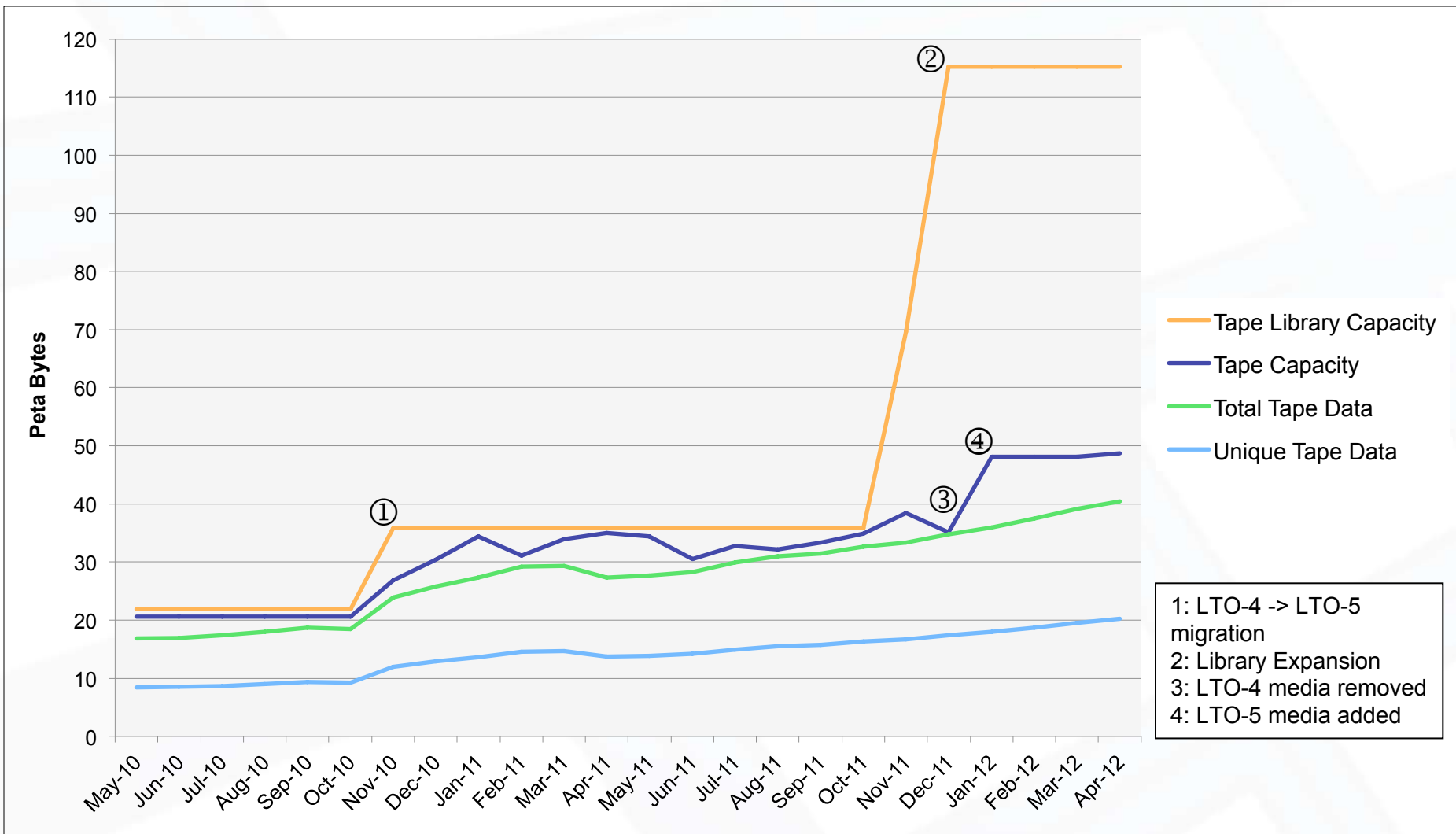


# Tape Archive Status

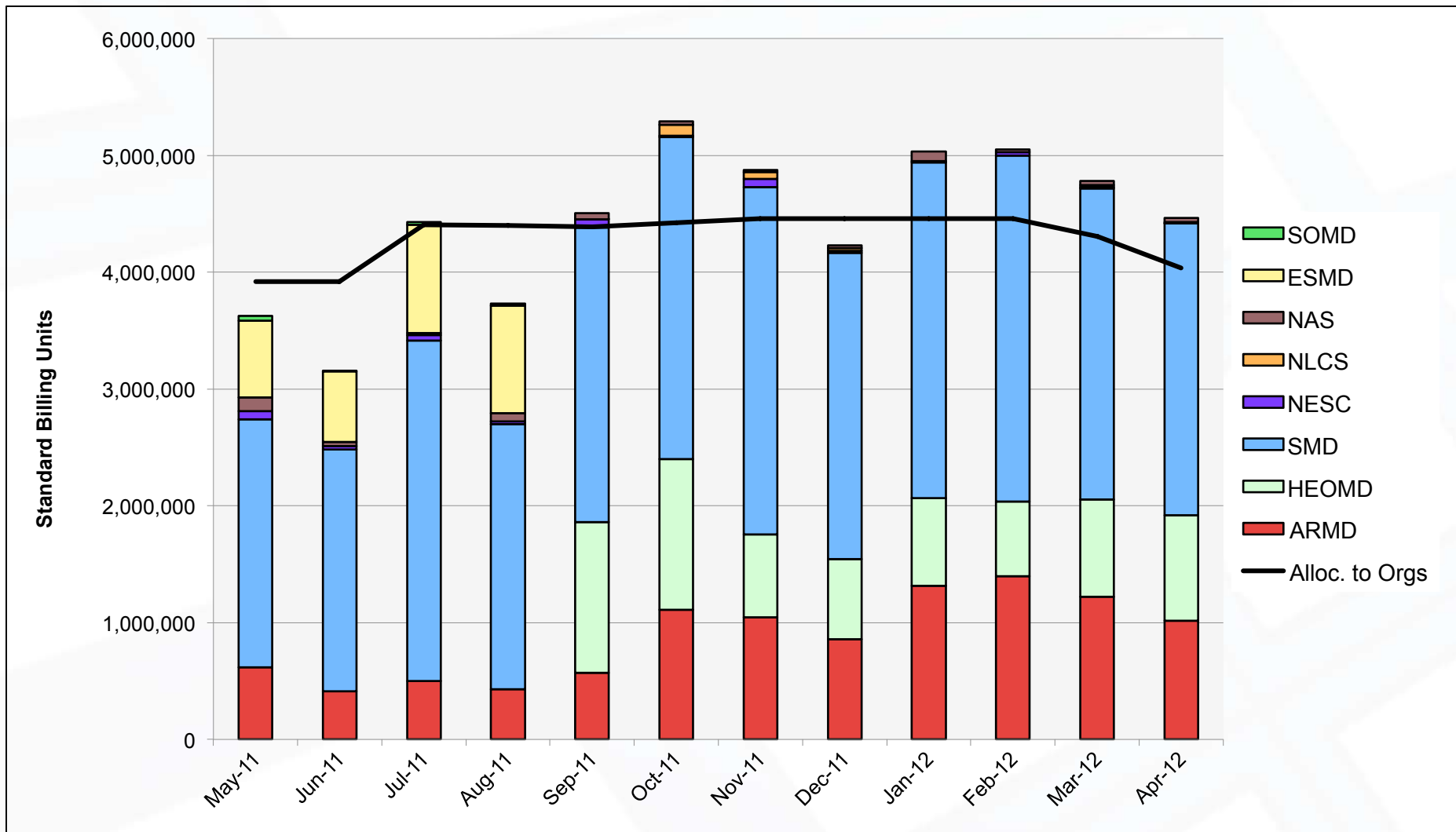


April 2012

# Tape Archive Status

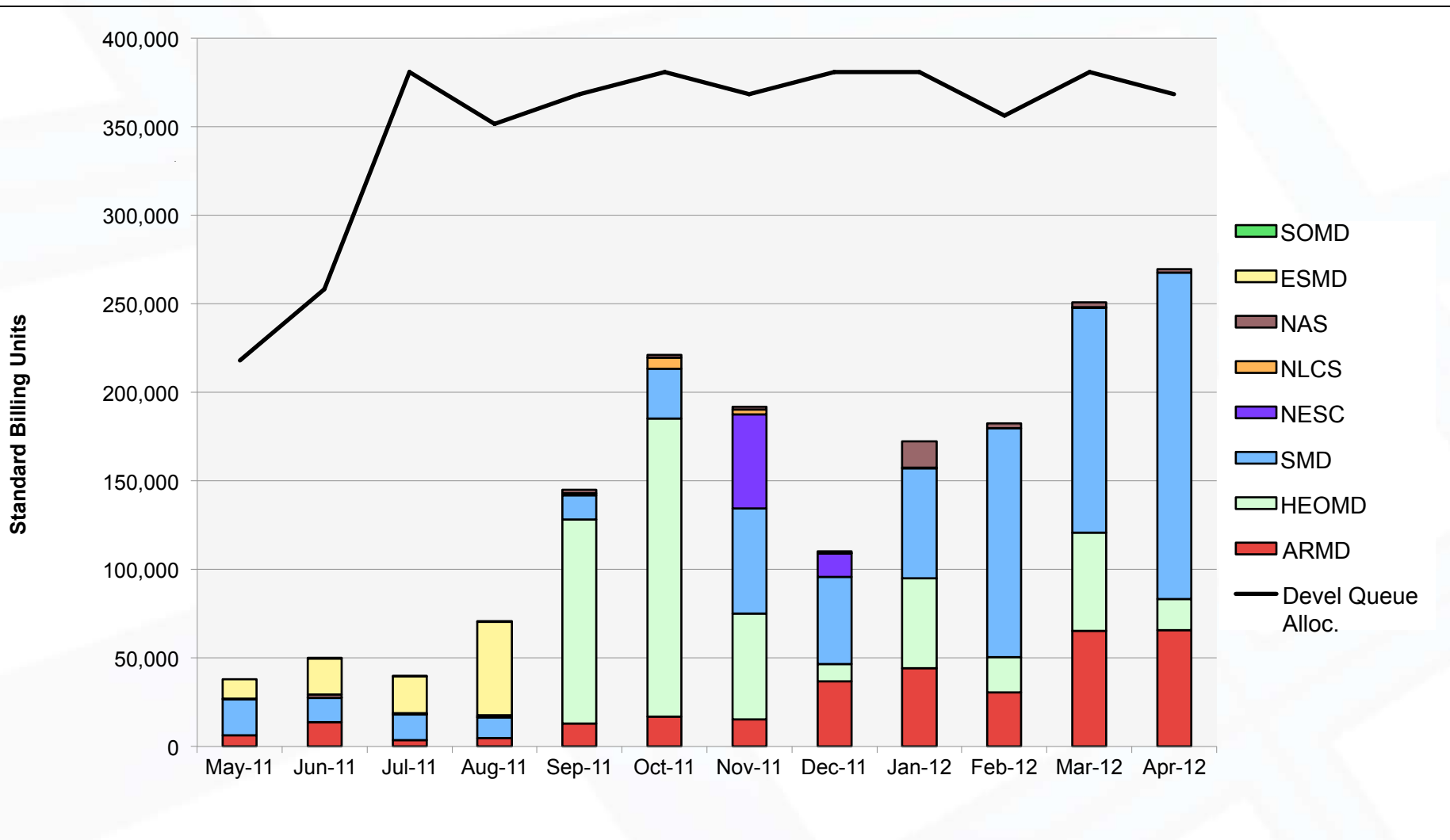


# Pleiades: SBUs Reported, Normalized to 30-Day Month

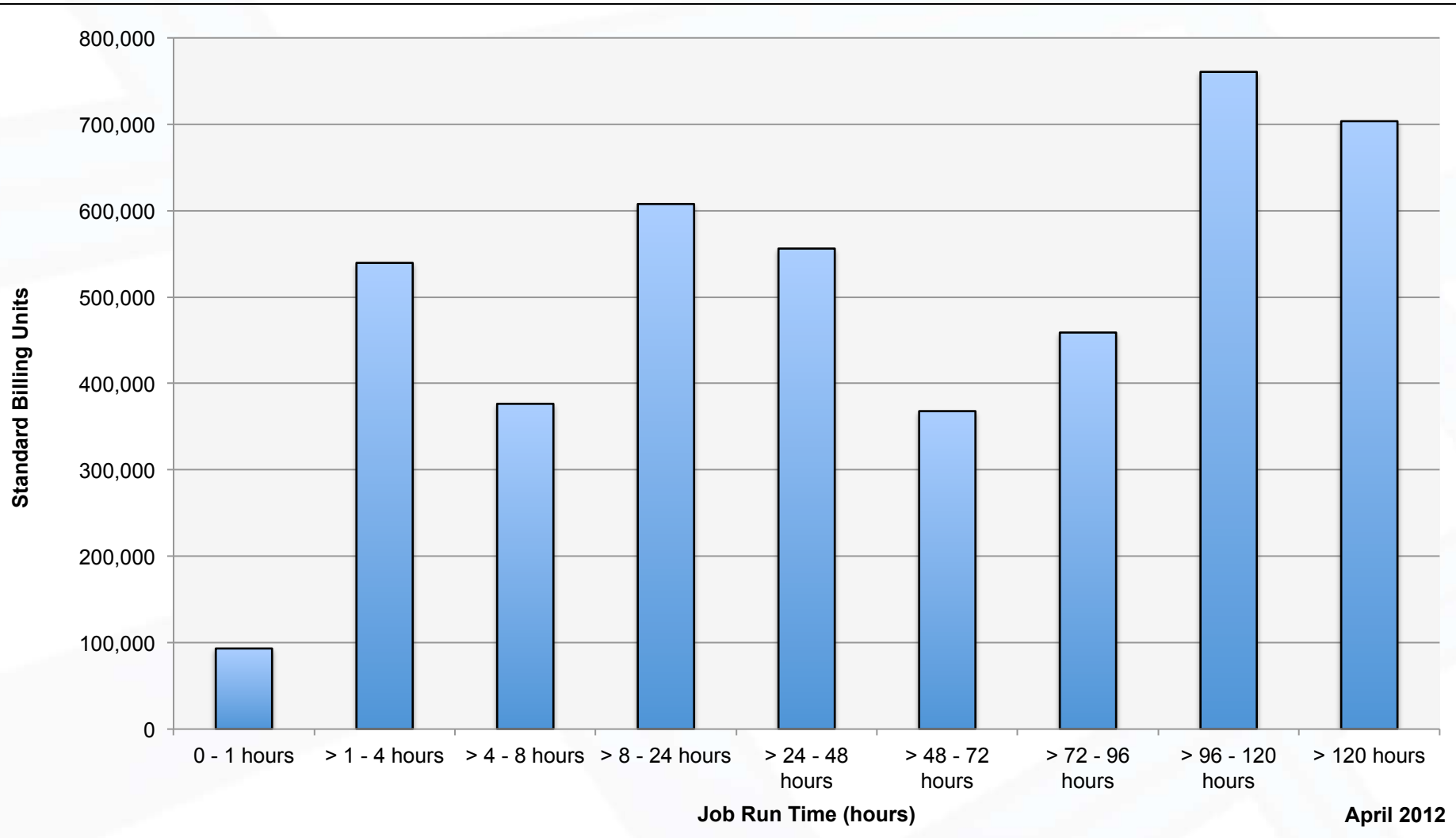




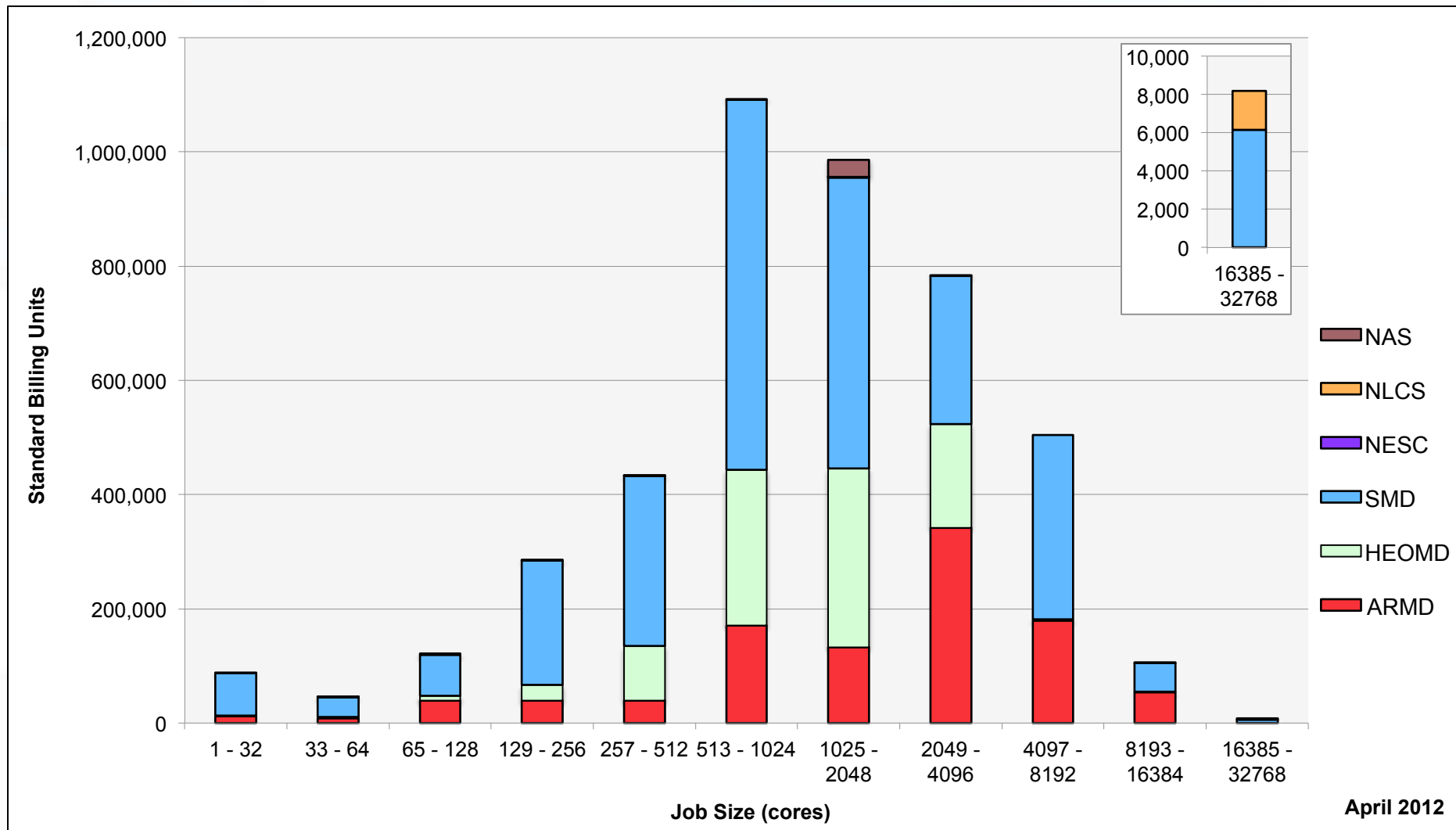
# Pleiades: Devel Queue Utilization



# Pleiades: Monthly SBUs by Run Time

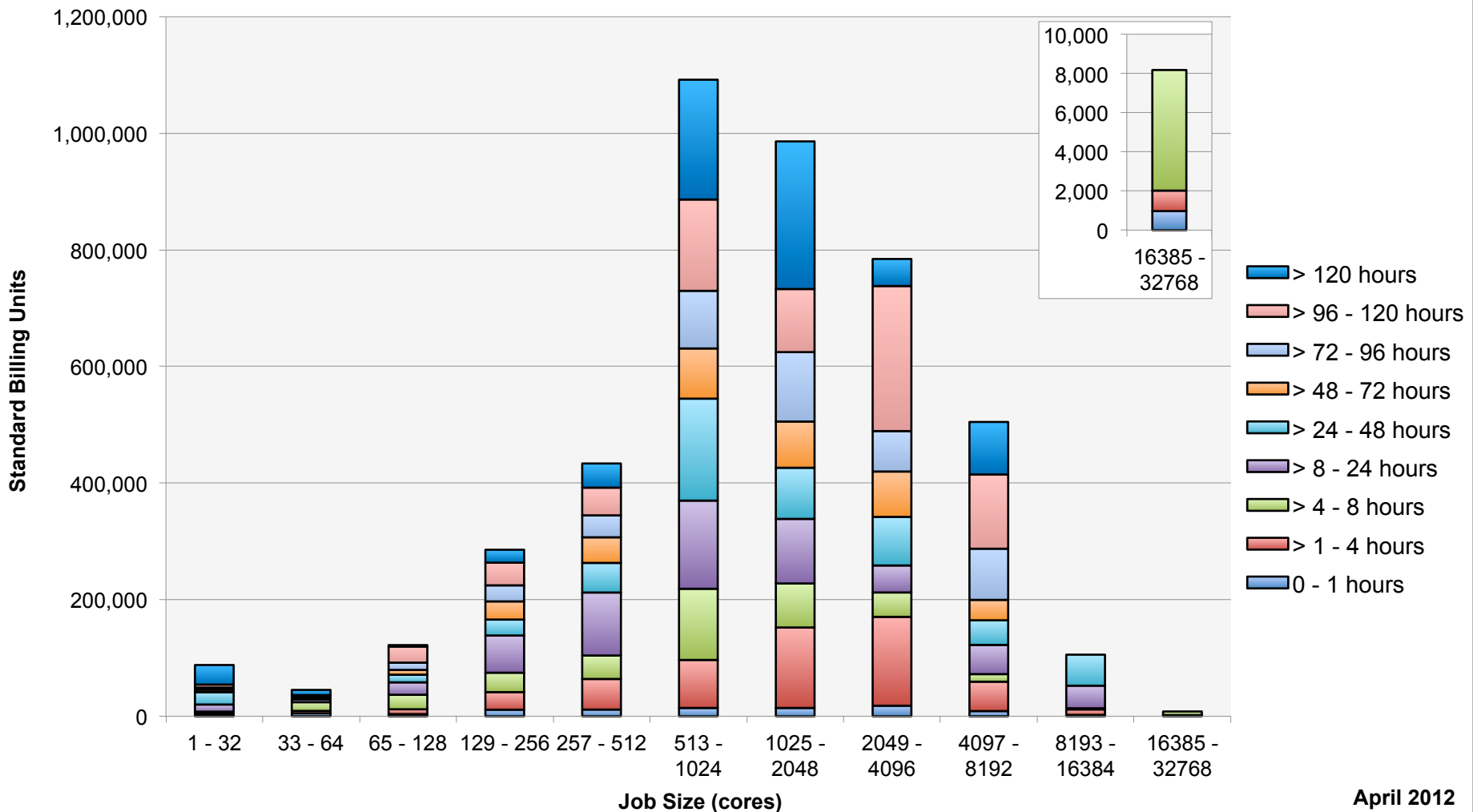


# Pleiades: Monthly Utilization by Size and Mission



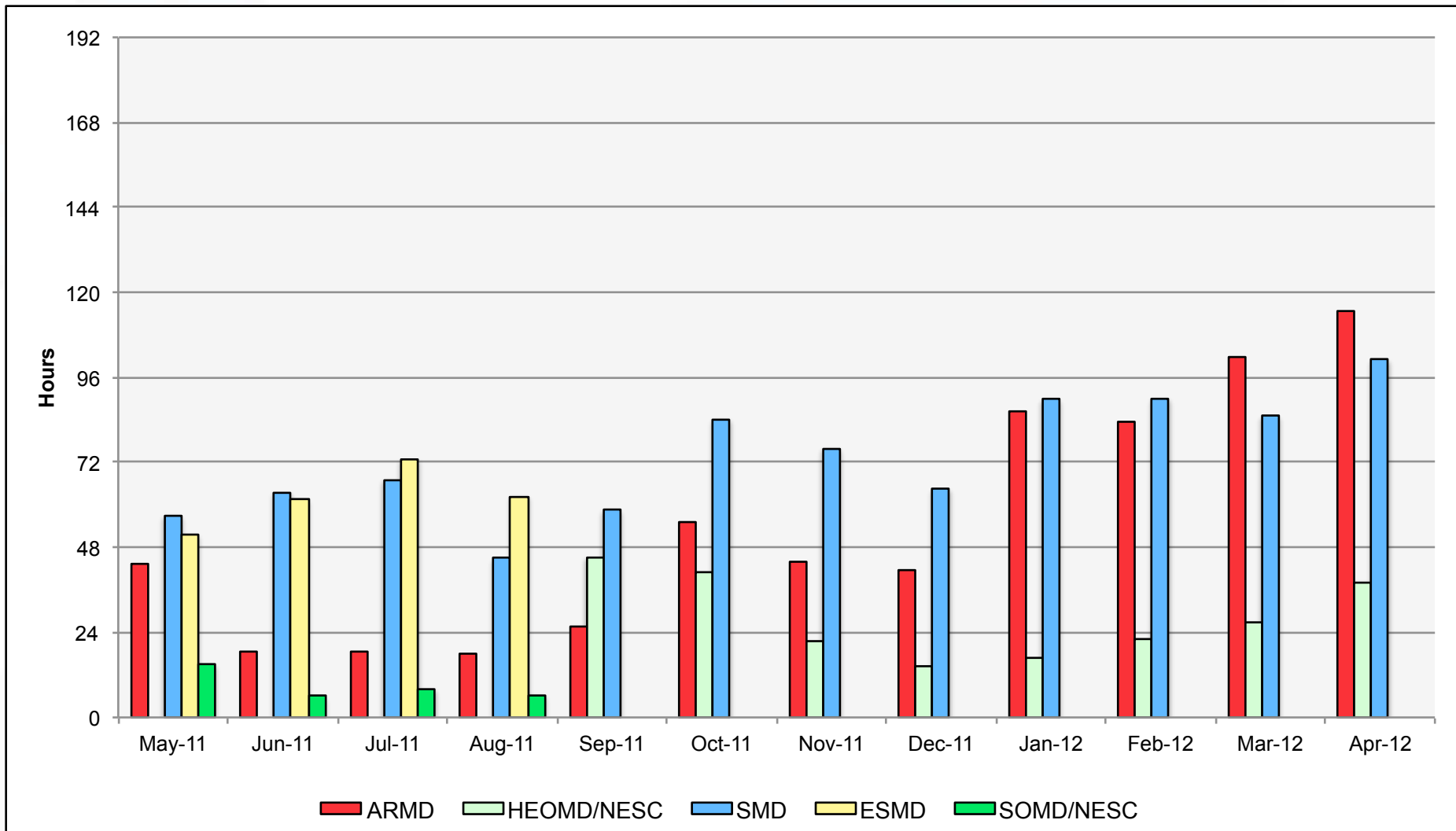


# Pleiades: Monthly Utilization by Size and Length

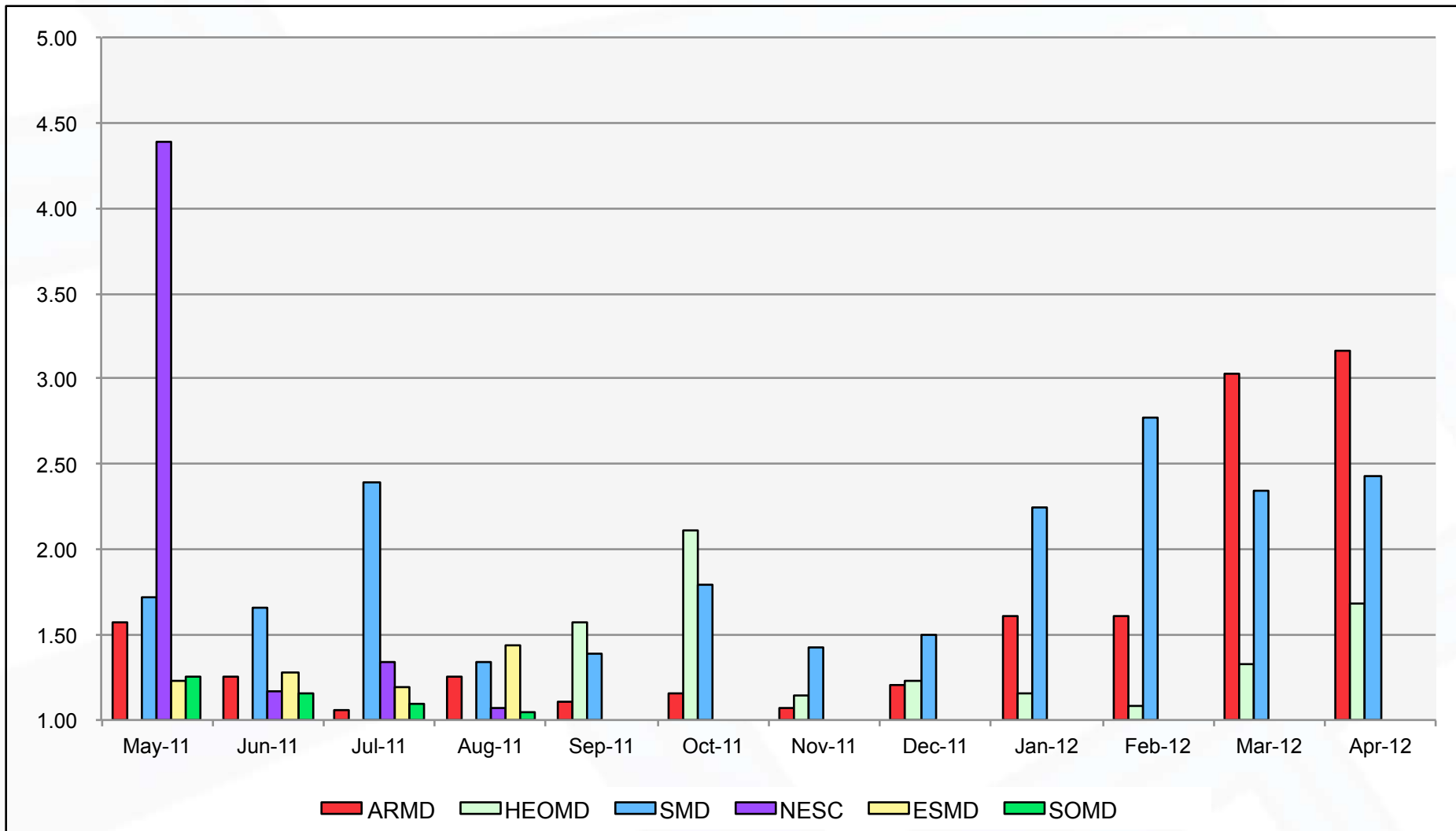


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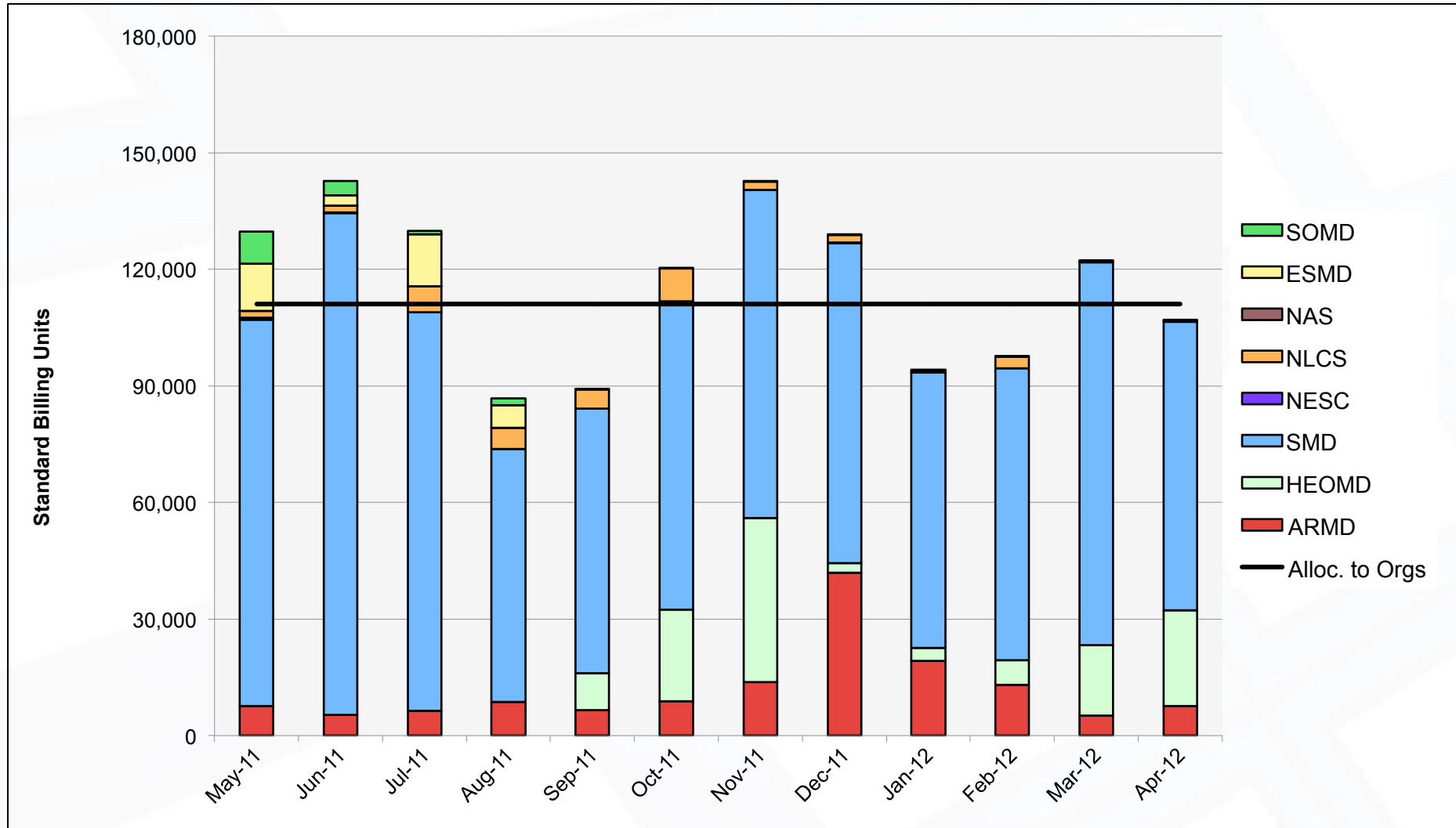
# Pleiades: Average Time to Clear All Jobs



# Pleiades: Average Expansion Factor

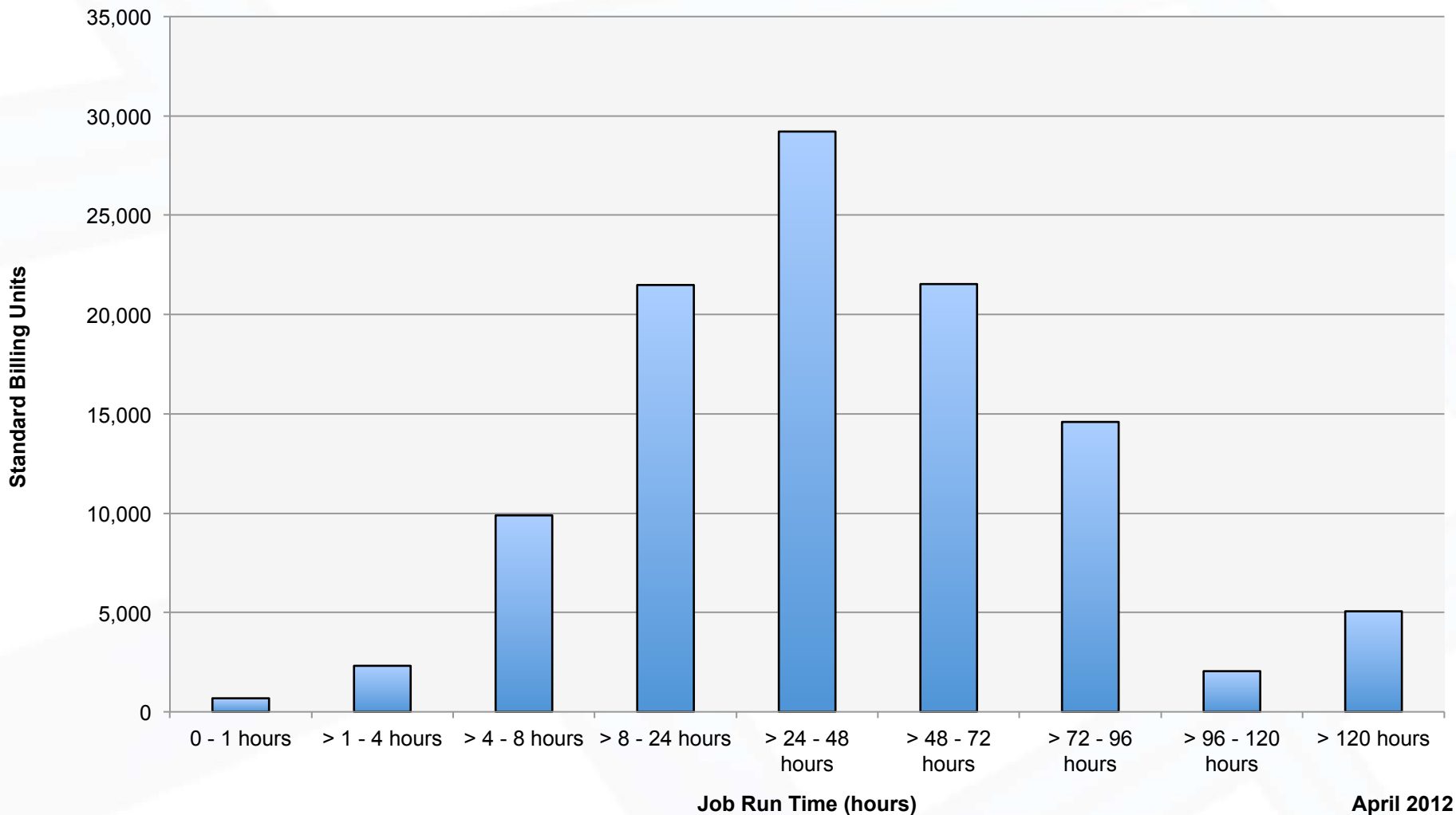


# Columbia: SBUs Reported, Normalized to 30-Day Month

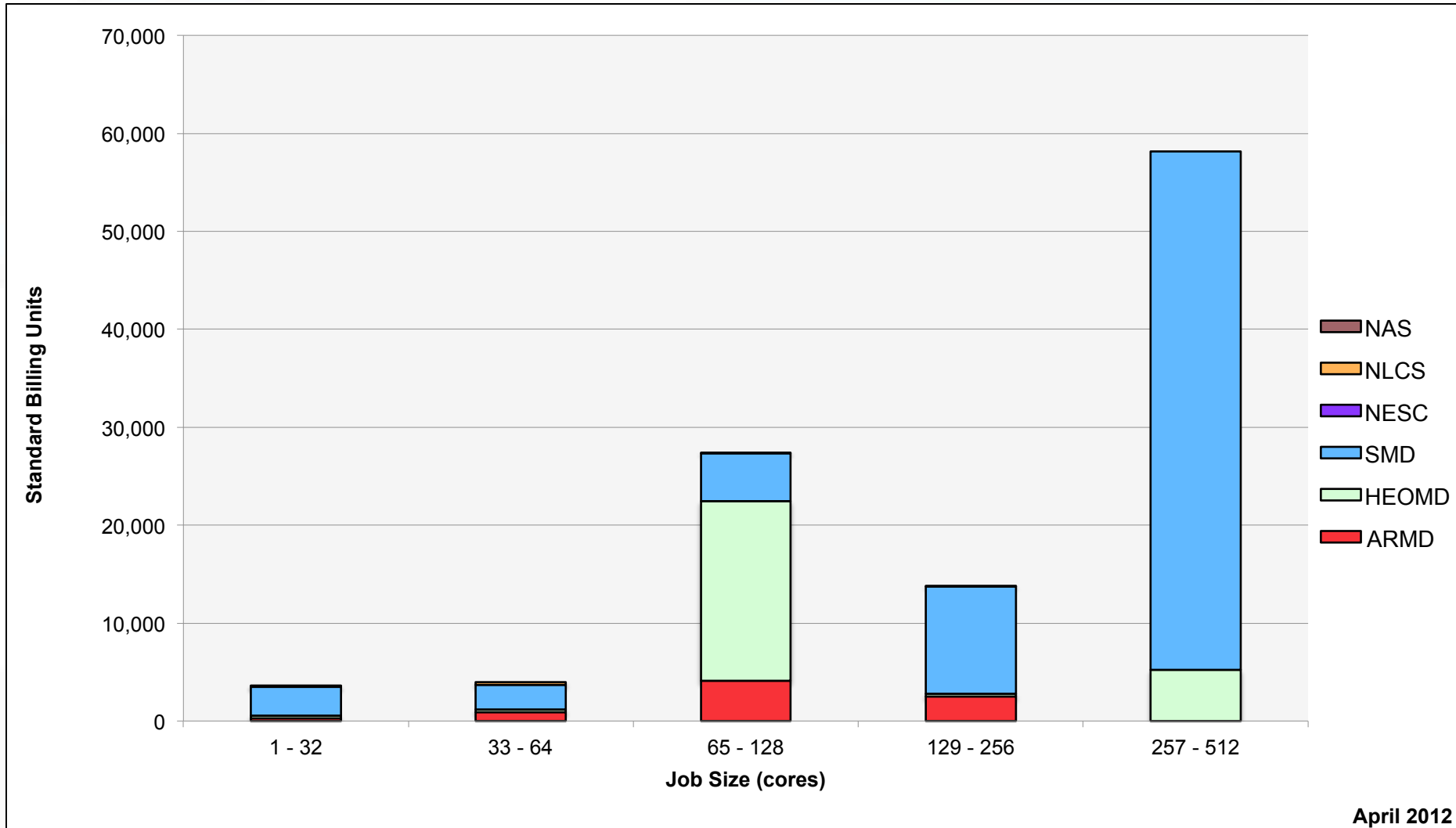




# Columbia: Monthly SBUs by Run Time

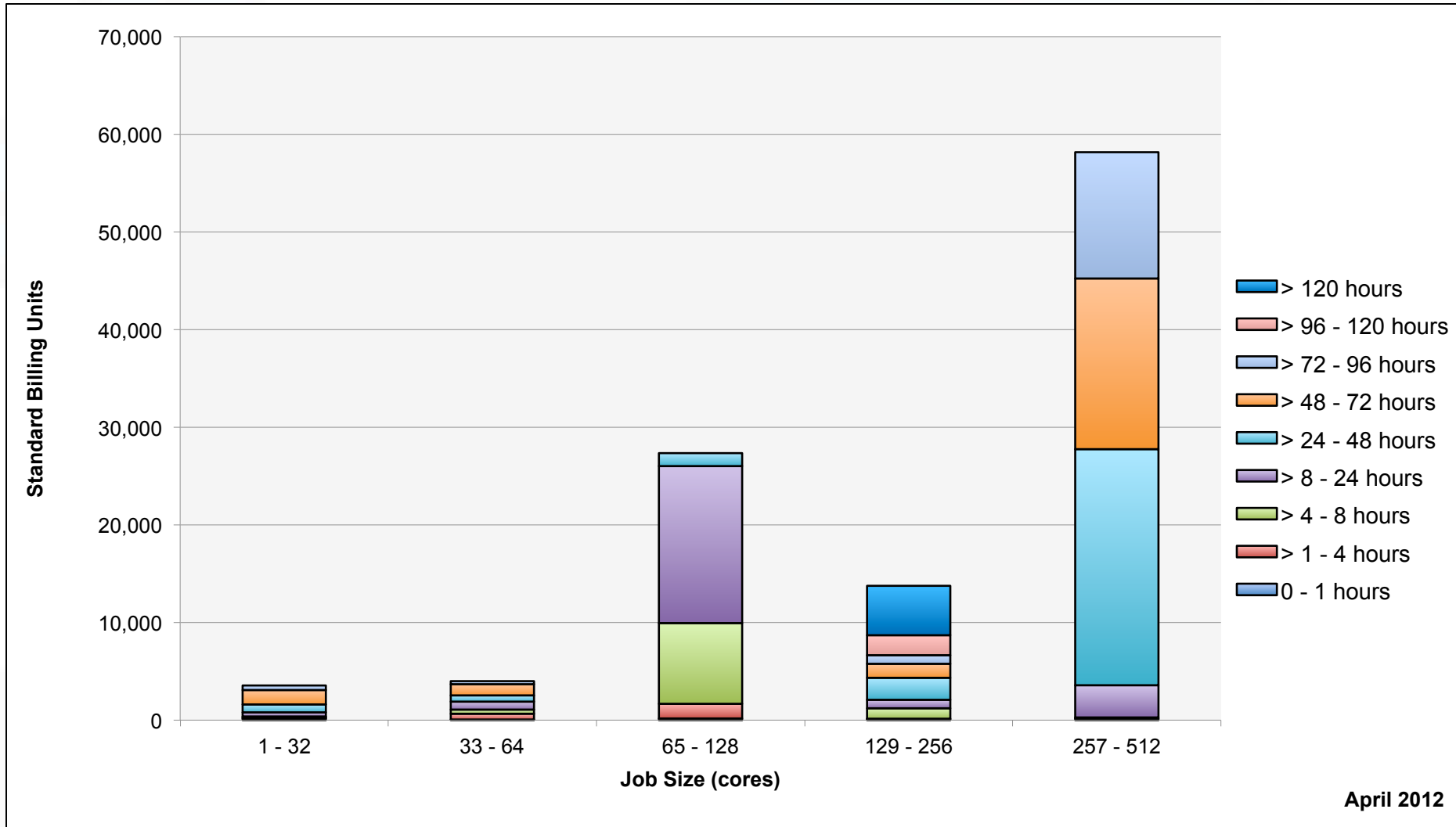


# Columbia: Monthly Utilization by Size and Mission



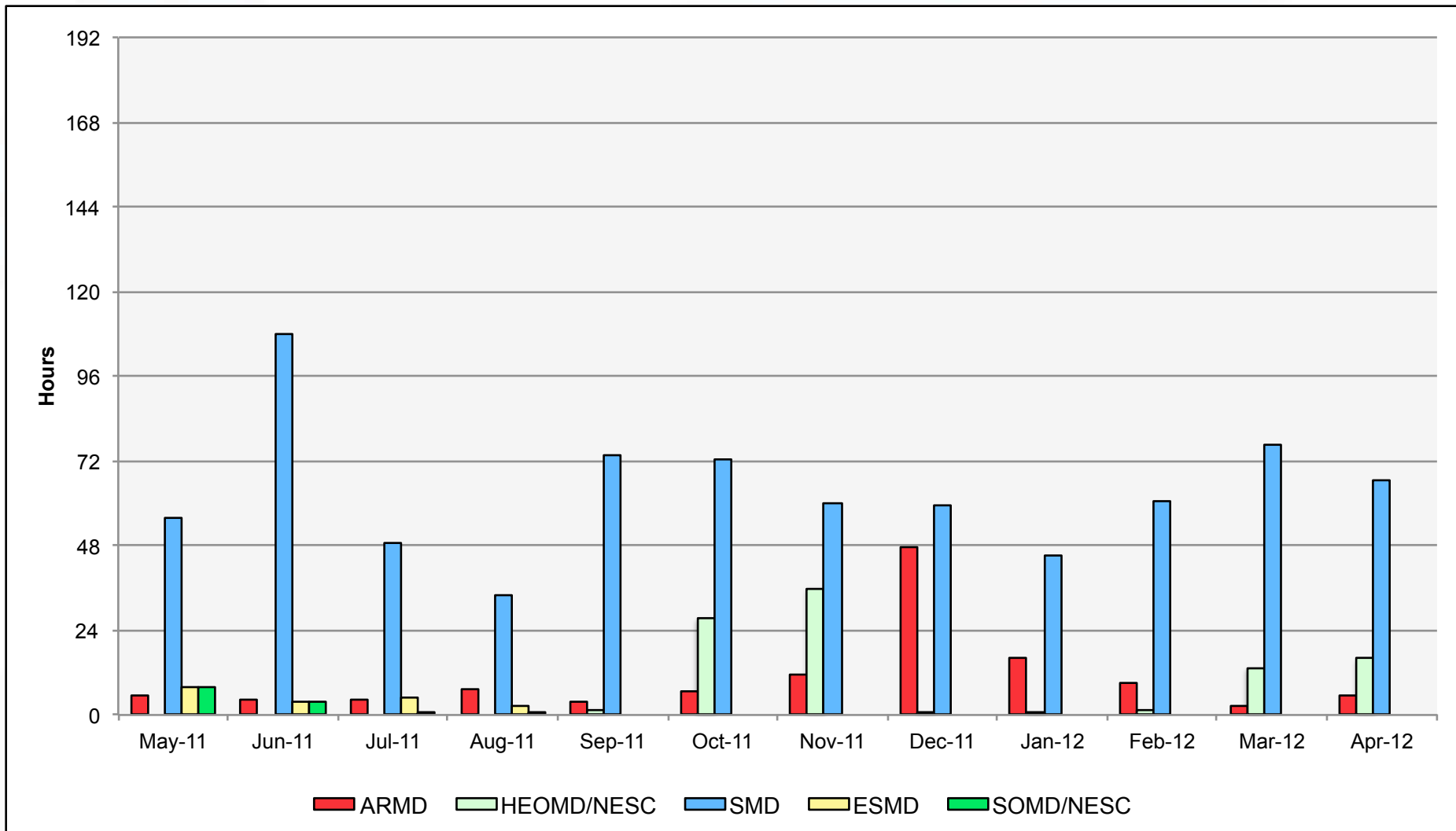
April 2012

# Columbia: Monthly Utilization by Size and Length



April 2012

# Columbia: Average Time to Clear All Jobs





# Columbia: Average Expansion Factor

